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EASTERN SPRUCE

. . . *an American wood*

Eastern spruce is the name commonly applied to three spruce species—white, black, and red. Its natural range extends from Newfoundland westward across Canada and southward into New England, New York, and northern portions of the Lake States. It also grows along high elevations of the Appalachian Mountains to western North Carolina and eastern Tennessee. The wood is moderately soft, medium to fine textured, usually straight and even-grained. The largest single use of eastern spruce is for paper pulp, which is manufactured into pulp board, newsprint, book and writing paper, wrapping paper, and rayon. The lumber is used primarily for prefabricated dwellings, mobile homes, furniture, and construction. Because of its excellent resonant qualities, it is highly prized for piano sounding boards and other musical instruments. It has moderately high shrinkage but is easily dried. It is easily worked, but rates low in nail-holding ability. It rates low in resistance to decay and is difficult to penetrate with preservatives.

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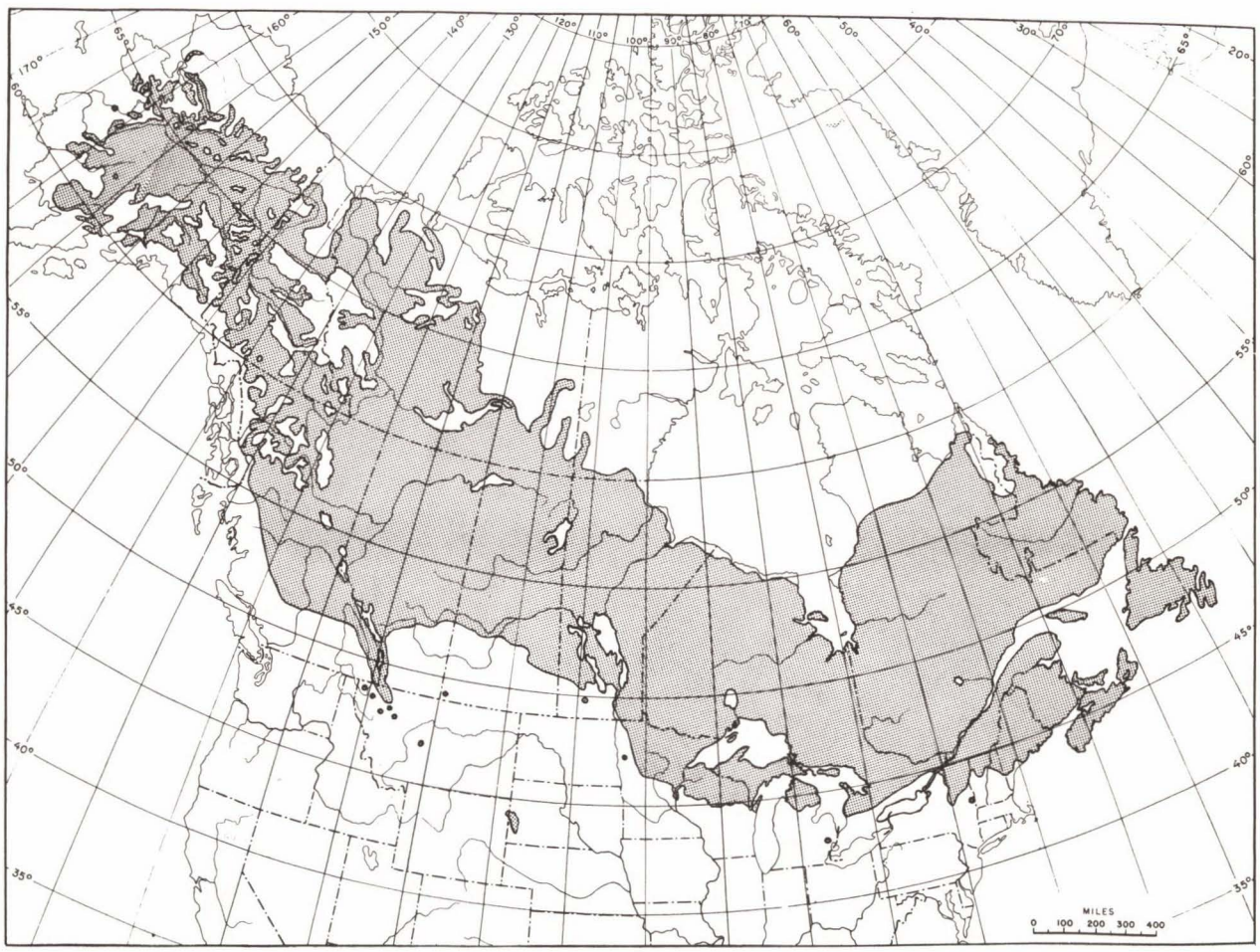

Figure 1.—Range of white spruce (*Picea glauca*). F-506612

EASTERN SPRUCE

. . . an American wood

M.D. Ostrander[1]

DISTRIBUTION

Three spruces—white (*Picea glauca* (Moench) Voss), black (*Picea mariana* (Mill.) B.S.P.), and red (*Picea rubens* Sarg.)—are collectively known as eastern spruce. The natural range of **white spruce** extends from Newfoundland and Labrador west across Canada to northwestern Alaska and southward through northern New England, New York, Michigan, Wisconsin, and Minnesota (fig. 1). In western Canada it is found east of the coastal mountains in British Columbia. Outlying stands also occur in the Black Hills of South Dakota and in Montana and Wyoming. White spruce grows under a variety of climatic conditions, ranging from the wet insular climate of Newfoundland to the semiarid conditions of southern Manitoba. It grows best on well drained porous soils at elevations up to 5,000 feet. In the eastern part of its range, it is generally found in mixtures with other conifers such as black spruce, red spruce, balsam fir, and jack pine, or in mixtures with aspen and paper birch. As a pioneer type, it also forms pure stands in abandoned fields in New England and the Maritime provinces of Canada. In western Canada it is found as pure stands or in mixtures with aspen, birch, and lodgepole pine.

Black spruce is one of the most abundant conifers in North America and has a natural range similar to that of white spruce (fig. 2). It too spans the continent, ranging from Newfoundland and Nova Scotia west and north across Canada to western Alaska. It extends south through northern New England, New York, and northern portions of the Lake States. Outlying stands occur in northern New Jersey and Pennsylvania. In western Canada it extends south to central British Columbia and southern Manitoba. Although most of its range is in Canada, good stands of this species occur in the northern portions of Minnesota and Michigan. Black spruce is primarily a tree of the northern interior swamps and lowlands. It is commonly found in cold, poorly-drained bogs throughout its range, and under such conditions forms dense slow-growing pure stands. Through most of its range black spruce occurs at elevations between 500 and 2,500 feet, although substantial stands occur at lower elevations in eastern Canada. In the Canadian Rockies and Alaska it grows up the slopes to the limits of tree growth. It usually is found in pure stands and in mixtures with other lowland softwoods, aspen, and birch.

The natural range of **red spruce** extends from Nova Scotia and New Brunswick in Canada, southward through New England and eastern New York. It continues southward at high elevations in the Appalachian Mountains to western North Carolina and eastern Tennessee (fig. 3). It occurs mainly on well-drained uplands and mountain slopes, and in the northern part of its range it grows at elevations from near sea level to about 4,500 feet. It occurs in nearly pure stands and in mixtures with balsam fir, white spruce, eastern hemlock, eastern white pine, paper birch, and other northern hardwoods.

DESCRIPTION AND GROWTH

The eastern spruces are coniferous evergreen trees of pyramidal form with needle-like leaves arranged singly on all sides of twigs and branches. Because of the many similiarities, it is sometimes difficult for even the expert to distinguish individual specimens of these species. Some authorities have even considered red and black spruce to be varieties of a single species.

Under good growing conditions in western Canada, **white spruce** may attain a height of 120 feet with a diameter of 48 inches. Near the northern limit of its eastern range, it seldom exceeds 85 feet and its

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NOTE: This publication supersedes unnumbered *Eastern Spruce*, issued 1945.

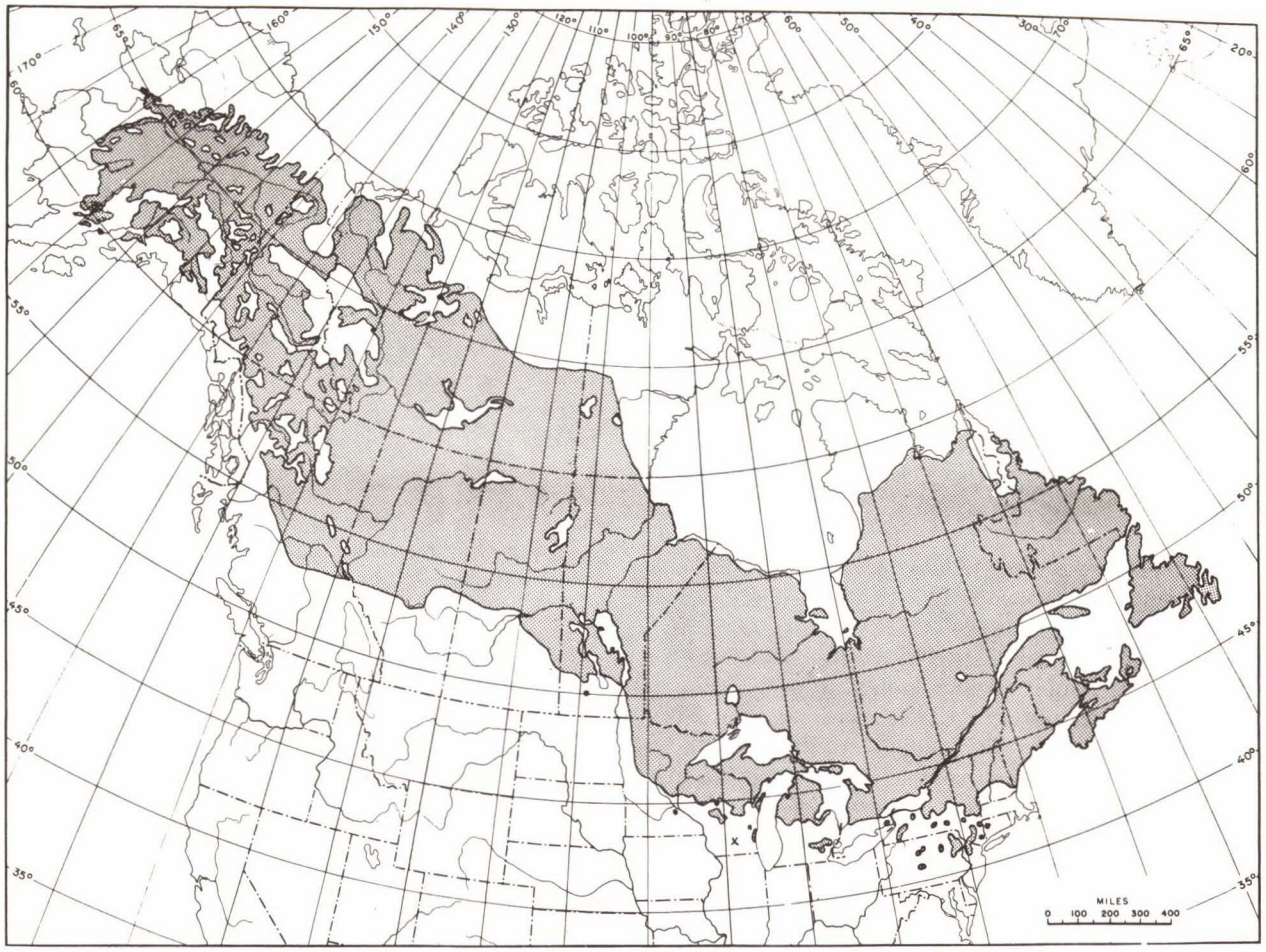

Figure 2.—Range of black spruce (*Picea mariana*). F-506613

diameter is seldom more than 24 inches (see front cover).

White spruce cones are usually longer than those of red or black spruce, ranging from 1½ to 2 inches; they are light brown with thin flexible scales and usually flat at the end. The needles are ⅓ to ¾ inch long, four-sided, blue green, and sharp to touch (fig. 4). The seeds are ⅛ inch long and are light brown with wings ¼ to ⅜ inch long. The bark is very thin, ¼ to ½ inch, scaly and pale gray to reddish brown (fig. 5).

Good seed crops occur every 2 to 6 years. Seeds germinate in late spring, and under good moisture conditions seedlings initially thrive in heavy shade. White spruce is subject to damage by several insect enemies, the most important being the spruce budworm. Its thin bark and shallow root system make the species very susceptible to fire and windthrow. White spruce has few diseases.

Black spruce is a small to medium-sized tree throughout most of its range and seldom attains heights greater than 50 feet or diameters of more than 12 inches (fig. 6). On the best sites, such as in the Ontario Clay Belt, it may attain a height of 90 feet with a diameter up to 20 inches. On the other extreme, at the northern limits of tree growth, it exists only as a prostrate shrub. The tree may attain the age of 250 years. It is normally a slow-growing tree, and although its form may vary from site to site, it is usually characterized by a slender straight trunk, an irregular open conical crown with short branches, and small cones. It is tolerant of shade but can be killed by prolonged flooding. Like the other spruces, it has very shallow roots and is thus susceptible to windthrow.

Black spruce cones are usually shorter than those of the other eastern spruces, ranging from ½ to 1¼ inches. They are nearly globular and remain on the branches for many years. The needles are short, ¼ to ½ inch, linear, often blunt, and dark bluish green with a whitish bloom (fig. 7). Seeds are ⅛ inch long, and are dark brown with wings ¼ to ⅜ inch long. The bark is very thin, ¼ to ½ inch, flaky, and grayish brown to reddish brown (fig. 8).

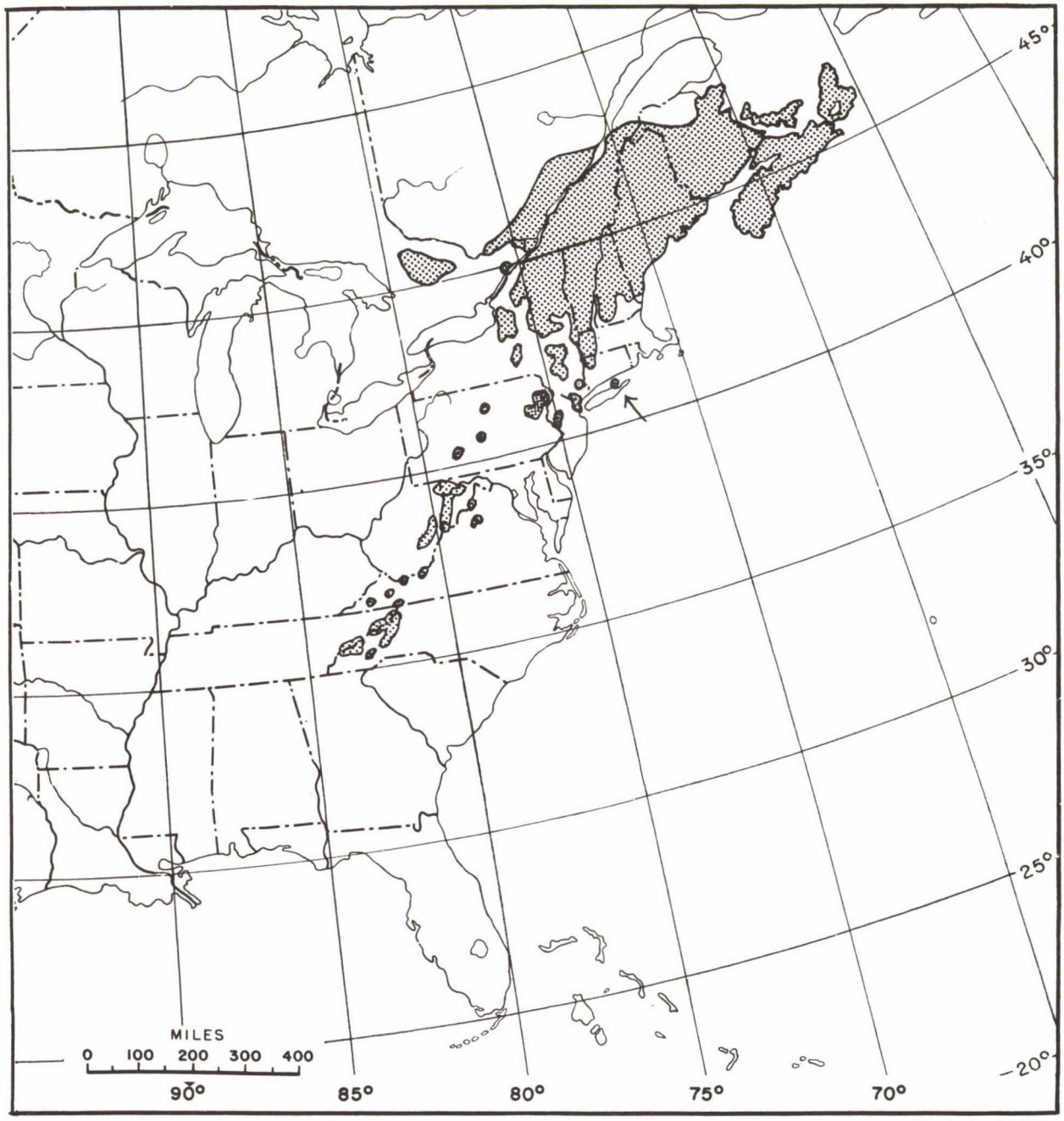

Figure 3.—Range of red spruce (*Picea rubens*). F-506614

Black spruce is a prolific seeder with heavy crops occurring about every 4 or 5 years. Some seeds remain viable in the cones for many years, and cones may drop seeds for several years. The species also regenerates by "layering" in bogs. Layering is the development of new root systems on lower branches that have become embedded in wet sphagnum moss.

Black spruce is quite susceptible to fire, windthrow, and flooding. It suffers some damage by spruce budworm when it grows in mixture with balsam fir. It also suffers some damage from butt rots, dwarf mistletoe, and needle rusts.

Red spruce is a medium sized tree; in the northern part of its range it attains heights of 60 to 80 feet with diameters of 18 to 24 inches (fig. 9). In the southern Appalachians it reaches greater size, with heights in excess of 110 feet and diameters up to 54 inches recorded. Open-grown trees develop broad conical crowns extending nearly to the ground; under forest conditions the crowns are restricted to the

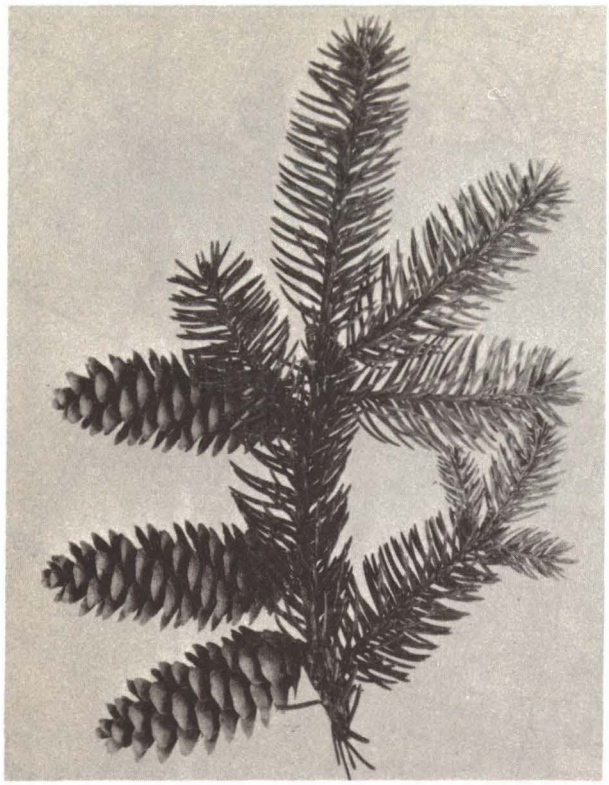

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Figure 4.—Needles and cones of white spruce.

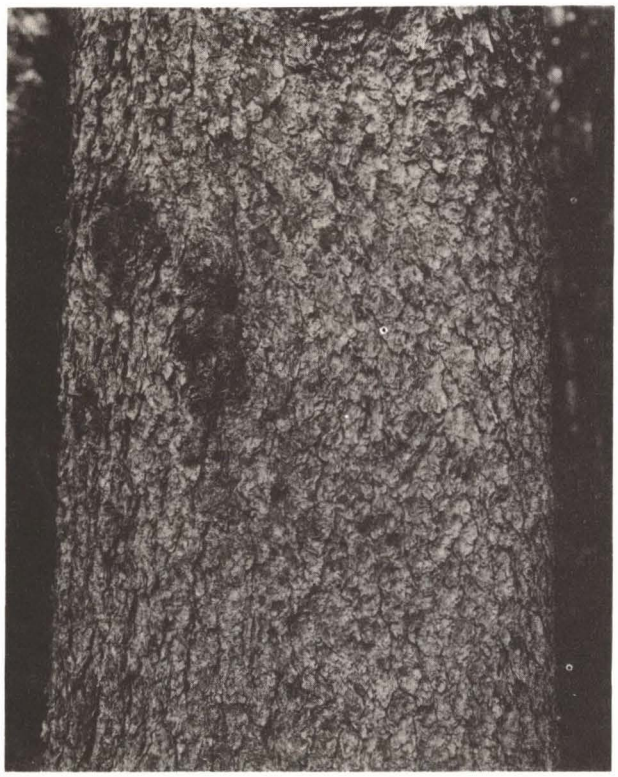

Figure 5.—Bark of white spruce.

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upper stem. The species matures in 200 years and its maximum age is reported to be about 400 years.

Red spruce cones are usually 1¼ to 2 inches long, chestnut brown at maturity, with rigid scales usually rounded on the margin. The needles are about ½ inch long, linear, four-sided, and are dark yellow green (fig. 10). Seeds are about ⅛ inch long, dark brown, with wings about ¼ inch long. The bark is usually ¼ to ½ inch thick, separating into irregular grayish to reddish brown scales (fig. 11). The relatively thin bark and shallow root system make this species susceptible to fire and windthrow, which are its worst enemies.

COMMON NAMES

Collectively, the wood of these three species is known as eastern spruce. The individual species also have other common names. Red spruce is commonly referred to as balsam or yellow spruce. White spruce

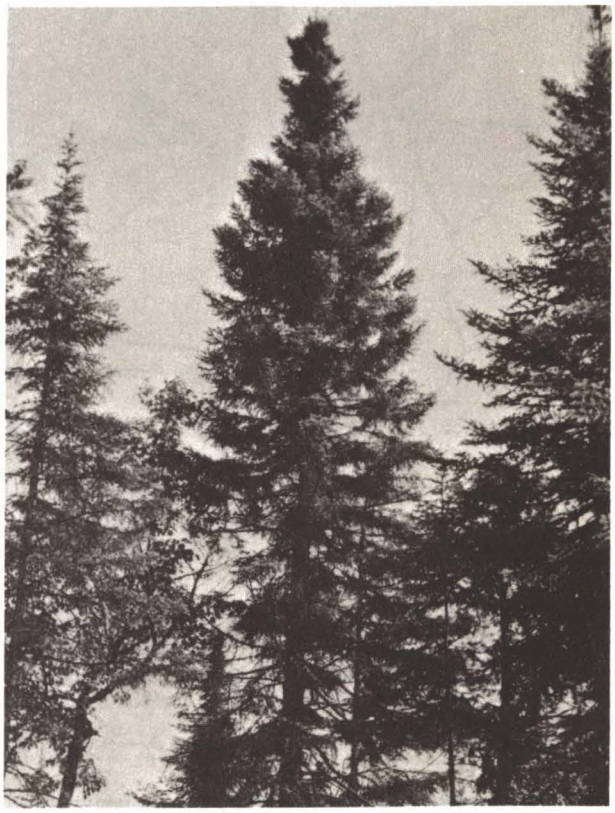

Figure 6.—Typical mature black spruce tree.

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is also known as Canadian spruce, skunk spruce and cat spruce; horticultural stock originating from the West is sometimes called Black Hills spruce. Black spruce is commonly called swamp spruce or bog spruce and sometimes, shortleaf black spruce.

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Figure 7.—Needles and cones of black spruce.

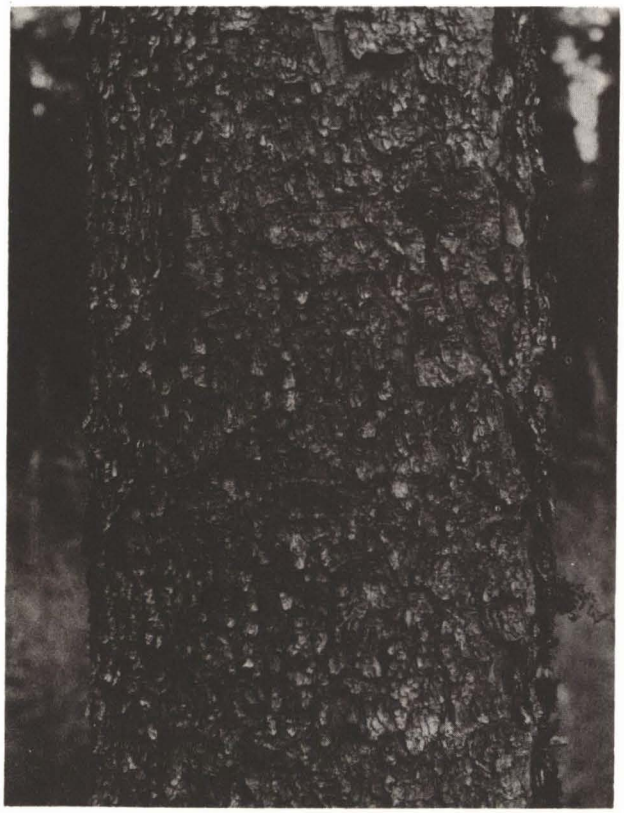

Figure 8.—Bark of 70 year old black spruce 8 inches in diameter. F-389014

RELATED COMMERCIAL SPECIES

In the eastern United States lumber produced from the three species is usually marketed as eastern spruce. In Canada the lumber is sometimes marketed as Canadian spruce. Varying amounts of balsam fir are sometimes marketed along with eastern spruce, particularly as studs and small dimension lumber. In Western Canada white spruce is marketed as white spruce or western white spruce; sometimes it is mixed with Engelmann spruce and sold as western spruce. Forest survey inventory and timber removal tables usually combine eastern spruce and balsam fir in national reports, although individual State reports usually separate the species.

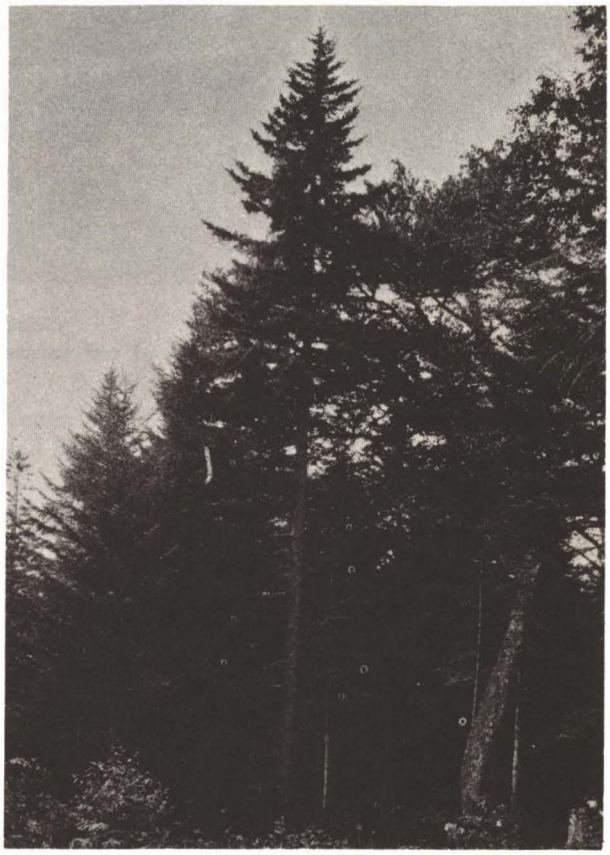

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Figure 9.—Medium sized red spruce in southern Appalachians.

SUPPLY

The total volume of eastern spruce in the United States is currently estimated at about 16.8 billion cubic feet. About half of this (38 billion board feet) is of sawtimber size. The balance, in pole-sized material, amounts to over 100 million cords. About 65 percent of the sawtimber is in Alaska, where all of it is white spruce. An additional 29 percent (mostly red spruce)

F-490496

Figure 10.—Needles and closed cones of red spruce.

is in the Northeastern States, and most of the remaining 6 percent (black and white spruce) is in the Lake States.

The bulk of eastern spruce timber is in Canada, and 1959 estimates indicate an accessible cubic foot volume of approximately 130 billion cubic feet. Forty percent of this is of sawtimber size, with an estimated volume of 140 billion board feet. Practically all of the eastern spruce sawtimber in Canada is white spruce.

PRODUCTION

Domestic production of eastern spruce lumber amounted to 440 million board feet in 1869 (fig. 12). Production gradually increased over the next 40 years and reached its peak in 1909 with a reported production of 1,466 million board feet. From 1909 to 1933 production gradually declined to a low of 60 million board feet in 1932. During World War II (1942–1946) production increased again to about 140 million board feet per year and has remained fairly stable since that time. New York State led in production during the early years, but since 1899 Maine has been the principal producing state, with West Virginia, New Hampshire, or Vermont in second place. Eastern spruce lumber production for the United States in 1969 (most recent figures available) was estimated at 141 million board feet, with Maine accounting for 88 million board feet, most of it red spruce.

In addition to lumber actually produced in the United States, about 130 million board feet of sawlogs were harvested in Maine and exported to Canada in 1969.

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Figure 11.—Bark of 12-inch red spruce in northern Maine.

The production and consumption of pulpwood from eastern spruce began in the late 1800's. By 1920, 2½ million cords of eastern spruce were being harvested annually and consumed by pulp mills in the United States. During the depression years (1930–1940), consumption of eastern spruce pulpwood declined to an average of 1½ million cords per year, but it subsequently climbed back to about 2 million cords annually during World War II. Although the total consumption of pulpwood has been increasing rapidly over the past several decades, the consumption of eastern spruce pulpwood has gradually declined because of the increased use of southern pine and hardwood pulpwood. Eastern spruce pulpwood production in the Northeast and the Lake States in 1969 had decreased to 1,234,000 cords. As it does in lumber, Maine led in eastern spruce pulpwood with an estimated 900,000 cords produced in 1969. Minnesota was second with 157,000 cords.

The production of eastern spruce lumber and pulp-

wood in Canada is much greater than the United States' domestic production. The most recent estimates (for 1963) put eastern spruce lumber production at 2,735 million board feet and pulpwood production at 9 million cords.

In addition to these products, limited amounts of eastern spruce timber are harvested for poles, pilings, boatbuilding, and cooperage stock.

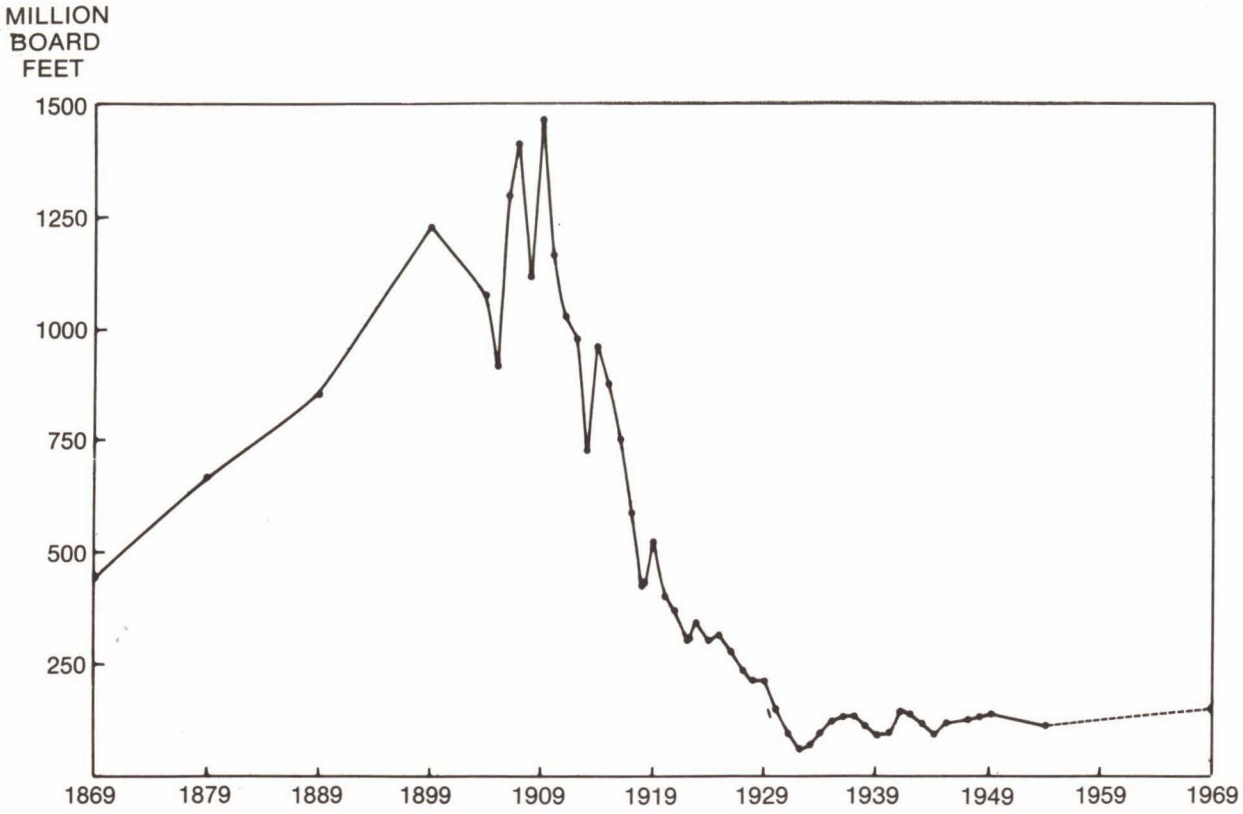

Figure 12.—Domestic production of eastern spruce lumber, 1869 to 1969.

CHARACTERISTICS AND PROPERTIES

The wood of red, white, and black spruce cannot be distinguished with certainty by either gross characteristics or minute anatomy. Normally, however, the heartwood of red spruce is nearly white with a slight tinge of red, while the heartwood of white and black spruce is a pale yellowish white. The sapwood of all three is usually lighter in color than the heart, and in mature trees ranges from 1 to 2 inches thick. The annual growth rings are distinct, with a marked difference in color between the summerwood and the springwood of the succeeding ring. The transition from springwood to summerwood is gradual, with the summerwood somewhat darker and narrower than the springwood. The distinguishing characteristic that readily separates the wood of spruces from that of true firs is the presence in the spruces of resin ducts or canals that are visable with a hand lens and appear as white flecks in the summerwood.

The wood is lustrous and without characteristic odor or taste. It is medium- to fine-textured, usually straight and even grained, and in the form of thin boards it has exceptional resonance qualities. It is moderately light in weight with an average specific gravity of approximately 0.37 green and 0.41 to 0.45 oven dried. The average weight of air dried eastern spruce at 12 percent moisture is 28 pounds per cubic foot. The wood is moderately soft and not very resistant to bending or end-wise compression but it is moderately stiff and therefore has unusual strength for its weight. It has moderately high shrinkage but is easily air dried or kiln dried. It is easily worked, glues well, has average paint holding ability, but rates low in nail holding ability. It rates low in resistance to decay and is difficult to penetrate with preservatives.

Eastern spruce is excellent for pulp and paper making and has long been used for this purpose. Because of its long fibers, light color, and freedom from resins it has always been in strong demand for the mechanical and sulphite pulp making processes. Small amounts are also used in the sulphate process. The pulp from both sulphite and sulphate processes has excellent color, bleaches easily, and produces strong papers of fine texture. The mechanical proc-

ess also yields a pulp of good color and good strength, suitable for all uses that require this type of pulp, such as newsprint, books, and wallpaper.

PRINCIPAL USES

The early shipbuilding industry of colonial New England created the first market for eastern spruce timber and appreciable amounts of red spruce were used for masts and spars. Later, as supplies of eastern white pine dwindled, eastern spruce lumber came into general use for building construction and industrial uses. In recent years the principal uses of eastern spruce lumber have been for containers, prefabricated dwellings, mobile homes, furniture, and pallets, as well as construction lumber. Lesser amounts are used in general millwork, sash and door construction, ladder rails, scaffold planks, and boat construction. Eastern spruce is highly prized for piano sounding boards and for other musical instruments, such as violins, that require a wood with excellent resonant qualities.

Recent statistics indicate that over 400 million board feet of eastern spruce lumber are used annually by the manufacturing industries of the United States; most of this volume is imported from Canada, and a substantial amount of it is manufactured from logs that have been exported from the United States.

The largest single use of eastern spruce is for paper pulp, most of which is pulped by the sulfite and mechanical processes. It is manufactured into a wide range of products, from pulp board, newsprint, and wrapping papers to high quality book and writing papers and rayon. As in the case of eastern spruce lumber, increasing imports from Canada are needed to supply the demand.

REFERENCES

Blythe, James E.
1969. Pulpwood production and consumption in the north central region—1967. USDA Forest Serv. Res. Bull. NC–6, 23 p.

Bones, James T., and David R. Dickson.
1970. Pulpwood production in the northeast—1969. USDA Forest Serv. Res. Bull. NE–22, 34 p.

Canada, Department of Northern Affairs and National Resources, Forestry Branch.
1957. Forest and forest products statistics, Canada. Bull. 106, 70 p.

Collingswood, G. H., and Warren D. Brush.
1964. Knowing your trees. 349 p. Revised and edited by Devereux Butcher. Am. For. Assoc., Washington, D.C.

Gill, Thomas G., and Robert B. Phelps.
1969. Wood used in manufacturing industries, 1965. U.S. Dep. Agric. Stat. Bull. 440, 101 p.

Harlow, W. M., and E. S. Harrar.
1958. Textbook of dendrology. 4th ed. 561 p. McGraw-Hill Inc.

Hutchinson, O. Keith.
1967. Alaska's forest resource. USDA Forest Serv. Res. Bull. PNW–19, 74 p.

Little, Elbert L., Jr.
1953. Check list of native and naturalized trees of the United States (including Alaska). U.S. Dep. Agric., Agric. Handbk. 41, 472 p.

Merrick, Gordon D.
1951. Wood used in manufacture—1948. USDA Forest Serv. Forest Resour. Rep. 2, 66 p.

Panshin, A. J., Carl de Zeeuw, and H. P. Brown.
1964. Textbook of wood technology, Vol. 1, Structure, identification, uses and properties of the commercial woods of United States, 2nd ed., 643 p. McGraw-Hill, Inc.

Steer, Henry B.
1948. Lumber production in the United States—1799–1946. U.S. Dep. Agric. Misc. Publ. 669, 233 p.

U.S. Department of Agriculture
1955. Wood handbook. U.S. Dep. Agric., Agric. Handbk. 72, 528 p.

USDA Forest Service.
1957. Red spruce (*Picea rubens*). Useful trees of the United States. No. 8, 4 p.

USDA Forest Service.
1958. Timber resources for America's future. USDA Forest Serv. Res. Rep. 14, 713 p.

USDA Forest Service.
1965a. Silvics of forest trees of the United States. U.S. Dep. Agric., Agric. Handbk. 271, 762 p.

USDA Forest Service.
1965b. Timber trends in the United States. USDA Forest Serv. Res. Rep. 17, 235 p.

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